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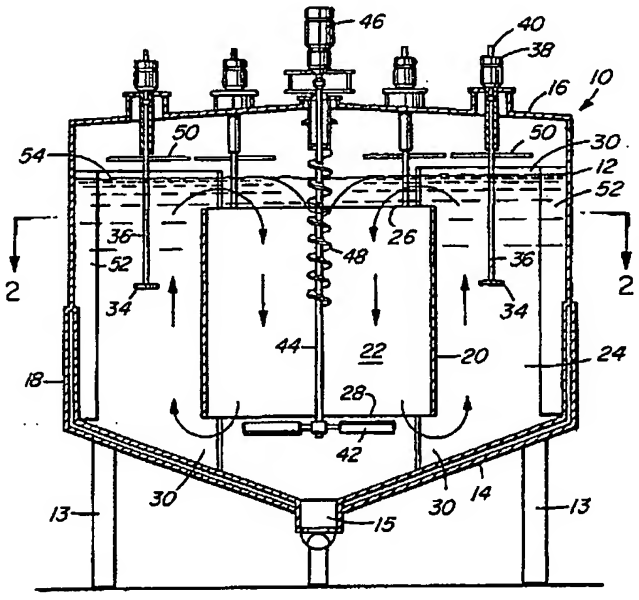
(54) Title: APPARATUS FOR MIXING AND AERATING LIQUID-SOLID SLURRIES



(57) Abstract: An apparatus for dispersing a gas in a liquid or slurry has a reaction vessel (10) with an inner zone (22) for the downward flow of liquid, an outer zone (24) for the upper flow of liquid, a plurality of aerators (34) in the outer zone (24) and a propeller (42) to induce downward flow in the inner zone (22) and promote mixing and circulation of the liquid/slurry. The apparatus is particularly suitable for use in the bacterial decomposition of organic waste matter, for efficiently aerating large volumes of waste/water slurries.

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APPARATUS FOR MIXING AND AERATING LIQUID-SOLID SLURRIES

Technical Field

The invention pertains to an apparatus for introducing and dispersing a gas in a liquid or slurry, preferably for aerating liquid-solid organic waste mixtures in order to accelerate the decomposition of the organic matter.

Background

In the field of organic waste treatment, decomposition of organic matter, such as vegetable wastes and sewage, can be effected by introducing suitable bacteria into a tank containing a slurry of the organic matter in water, while aerating and mixing the slurry. Thorough aeration of the slurry, in the form of fine air bubbles dispersed throughout the slurry, accelerates such decomposition by providing ample oxygen to the bacteria.

In International Publication No. WO-97/11034, published March 27, 1997, there is disclosed a submersible mixing impeller for use in effecting aeration of liquids in slurries. It has been found that in a reaction vessel, typically a cylindrical tank, having a diameter up to about 14 feet, a single such impeller is able to efficiently aerate and mix the slurry. However, in reaction vessels having larger diameters, a single mixing impeller is insufficient to circulate the entire volume of slurry, resulting in uneven digestion of the biodegradable material, as evidenced by uneven temperatures in different parts of the tank. As a result, longer periods of time are required to effect complete digestion of the waste material. The use of such larger reaction vessels is very

reaction vessel. The bottom wall 14 and the lower part of the sidewall 12 have a steam jacket 18 to provide for heating of the contents of the reaction vessel.

A cylindrical wall 20 is suspended within the reaction vessel 10. The cylindrical wall 20 divides the reaction vessel 10 into a radially inner zone 22 and a radially outer zone 24. The wall 20 is open at its upper end 26 and at its lower end 28 and does not extend to the top cover 16 and bottom wall 14, permitting the slurry to flow between the inner zone 22 and the outer zone 24.

Radially-extending partition walls 30 are preferably provided, extending between cylindrical wall 20 and outer sidewall 12, dividing the outer zone 24 into sections 32. Six such partition walls 30 are provided in the embodiment illustrated in the drawings, forming six sections 32. The partition walls 30 support cylindrical wall 20 and preferably extend to the bottom wall 14 of the reaction vessel.

Mixing impellers 34 are provided in outer zone 24, one in each section 32. The mixing impellers (i.e. aerators) 34 have outwardly extending blades and are of the type, known in the prior art, that draw gas down a hollow shaft as they rotate with the shaft, and eject it into the liquid or slurry in which they are submerged. Preferably, mixing impeller 34 is of the type described in International Publication No. WO 97/11034, published March 27, 1997, entitled "Submersible Mixing Impeller," and more particularly in Fig. 5 thereof. Each mixing impeller 34 is submerged in the liquid or slurry

zone 24 and thus promote a smooth upward flow of slurry within such zone.

The above-described apparatus is used in the following manner. The organic matter to be treated is introduced in slurry form into the reaction vessel 10 through a port (not shown in the drawings) in the top cover 16. Typically, up to about 11% of solids in the slurry is preferred. Suitable bacterial cultures for the aerobic decomposition of the organic waste are added to the slurry, typically by introducing treated slurry from a previous batch. The propeller motor 46 is actuated, rotating the propeller 42. Impeller motors 38 are actuated, rotating the impeller shafts 36 and impellers 34. Rotation of the impellers 34 causes air in the atmosphere to be drawn in through inlets 40, and be expelled through exit ports in the impellers 34 into the slurry in the outer zone 24 as fine bubbles. The bubbles rise and induce an upward flow of slurry in outer zone 24. As they rise, air in the bubbles dissolves in the slurry and is available for use by the bacteria in the slurry. Undissolved air escapes at the liquid surface 54 into the airspace in the vessel. In the inner zone 22, a downward flow of slurry is induced by the rotation of propeller 42. Slurry that comes to the top of the outer zone 24 flows inward over the top edge 26 of cylindrical wall 20 into the inner zone 22. Such slurry, substantially depleted of air bubbles, which have either dissolved or escaped at the surface, flows downward in the inner zone, by virtue of its density, i.e. being denser than the bubble-filled slurry rising in the outer zone, and the effect of propeller 42 and flights 48. As such slurry passes the lower edge 28 of cylindrical wall 20, it flows outward and upward into

WHAT IS CLAIMED IS:

1. An apparatus for dispersing a gas in a liquid, comprising:

(a) a vessel having a circumferential sidewall;

(b) a radially inner zone within said vessel for the downward flow of said liquid;

(c) a radially outer zone between said inner zone and said circumferential sidewall for the upward flow of said liquid within said vessel;

(d) a propeller mounted on a propeller shaft, said propeller shaft extending generally vertically through said inner zone, and means for rotating said propeller, such that rotation of said propeller induces a downward flow of liquid in said inner zone; and

(e) a plurality of aerators radially arrayed in said outer zone, each said aerator being mounted on an upwardly-extending rotatable gas intake tube and having means for rotating said aerator, such that rotation of said aerator draws gas down through said gas intake tube and disperses said gas through said aerator into said liquid in said outer zone.

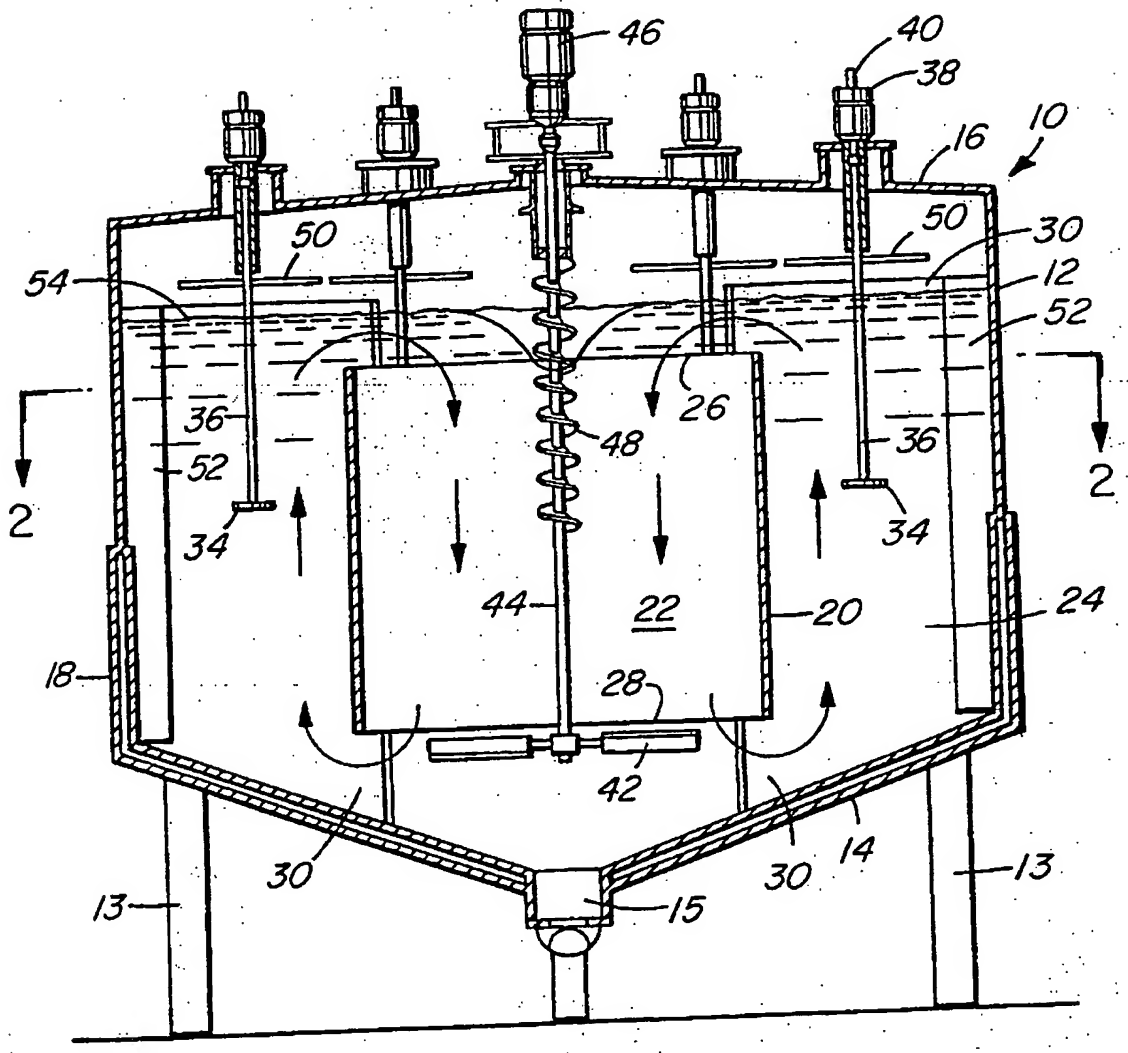
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FIG. 1

INTERNATIONAL SEARCH REPORT

International Application No
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A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 B01F3/04 //C02F3/20

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
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Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	EP 0 071 767 A (KLOECKNER WERKE AG) 16 February 1983 (1983-02-16) the whole document	1-5
Y	WO 97 11034 A (DYK BERNHARD VAN) 27 March 1997 (1997-03-27) cited in the application the whole document	1-3,5
Y	US 5 874 003 A (ROSE BRYAN L) 23 February 1999 (1999-02-23) column 6, line 19 - line 32; figure 1	4
Y	US 2 077 445 A (HARRY V WALLACE) 20 April 1937 (1937-04-20) the whole document	1,2

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

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"P" document published prior to the international filing date but later than the priority date claimed

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/CA 00/01432

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